EP 00/02920

(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 002 920 A1**

(12) EUROPEAN PATENT APPLICATION

(21) Application number: **78300846.9**

(22) Date of filing: **18.12.78**

(51) Int. Cl.²: **G 02 F 1/13**

(30) Priority: **20.12.77 GB 5304177**
12.04.78 GB 1442478

(43) Date of publication of application: **11.07.79**
Bulletin 79/14

(84) Designated Contracting States: **CH DE FR NL**

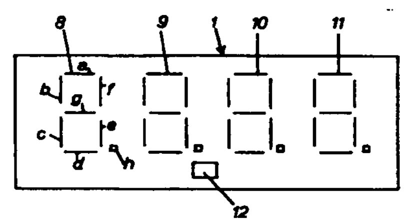
(71) Applicant: **The Secretary of State for Defence in Her Britannic Majesty's Government of the United Kingdom of Great Britain and, Northern Ireland Whitehall, London S.W.1. (GB)**

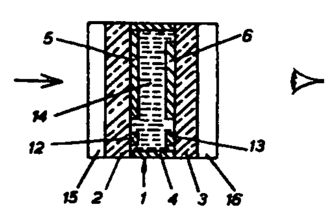
(72) Inventor: **Hilsum, Cyril, 24, Geraldine Road, Malvern Hereford and Worcester (GB)**
Inventor: **Raynes, Edward Peter, 23, Leadon Road Hall Green, Malvern Hereford and Worcester (GB)**

(74) Representative: **Edwards, John Brian et al, Procurement Executive Ministry of Defence Patents 1 A (4), Room 1932, 19th Floor Empress State Building Lillie Road, London SW6 1TR (GB)**

(54) Liquid crystal displays.

(57) A liquid crystal display comprises two transparent slides (2, 3) containing a thin layer (14) of liquid crystal material which may be nematic or cholesteric. Addressing electrode structures (5, 6) on the inner faces of the slide allow voltages to be applied across the layer (14) to cause an observable display effect. The voltage at which an observable display occurs is temperature dependent. In this invention sensing electrodes (12, 13) are connected in series with a reference impedance (Z_f). With a constant supply voltage (V_o) across the sensing electrodes (12, 13) and reference impedance (Z_f) the voltage (V_{LC}) developed between the sensing electrodes (12, 13) varies with temperature of the liquid crystal layer (14). This voltage (V_{LC}) variation is used to control the voltages applied to the addressing electrodes (5, 6) to compensate for temperature variations in the layer (14).





EP 0 002 920 A1

This invention relates to liquid crystal displays and concerns the compensation of electrical characteristics with temperature.

Liquid crystal displays are commonly formed by enclosing a thin, typically 12 μm thick, layer of liquid crystal material between two glass slides. Electrodes on the slides inner face enable a voltage to be applied across the liquid crystal layer.

Application of a voltage above a threshold value causes a change in the molecular alignment of the liquid crystal molecules i.e. to an 'ON' state. On removing the voltage the molecules relax back to their 'OFF' state.

This voltage controlled molecular alignment is used in various types of liquid crystal displays, e.g. twisted nematic, and phase change effect displays. To display numerics, symbols, or waveform parts of the layer are caused to be ON whilst other parts are OFF. This is achieved by shaping the electrodes into e.g. 7 bar displays, or e.g. arranging the electrodes as row or column strip electrodes on the two slides to form an x, y matrix, or radial and curved, strip electrodes to form a polar co-ordinate ($r - \theta$) display.

An x, y or r, θ matrix array or seven bar display arranged in a matrix forma may be addressed in a multiplexed manner, e.g. apply voltages to the whole display a line at a time. If the scan time is much shorter than the natural response time of the liquid crystal the display appears constant (no flicker).

The threshold voltage of a liquid crystal material, for a given layer thickness, varies with temperature and limits the complexity of multiplexed displays.

One way of overcoming this problem of threshold voltage variation is to maintain the liquid crystal layer at a uniform temperature using sensors and heaters.

According to this invention a method of compensating for threshold voltage variation with liquid crystal temperature of a liquid crystal display cell comprises the steps of applying a voltage between a critical value and a saturation value to at least a part of a liquid crystal layer, monitoring the capacitance of that part of the layer and using capacitance changes with temperature to control voltage levels applied to the cell.

According to this invention apparatus for carrying out the above includes a liquid crystal cell comprising two spaced slides, at least one of which is transparent, having on their facing surfaces electrode structures, a layer of a liquid crystal material contained between the slides and further includes means for applying across at least a portion of the layer and a reference impedance arranged in series, a voltage, and means for using the voltage developed across the portion of layer to control the voltage level applied to the remainder or display portion of the cell.

The reference impedance may be adjustable and may be resistive, inductive, capacitive or any suitable combination thereof.

The means for using the voltage developed across the portion of the layer may include an amplifier which adds or subtracts a control voltage from a supply voltage applicable to the display portion of the cell.

In large displays, e.g. matrix addressed displays, the capacitance may be monitored at different parts of the layer independently and used to compensate voltage applied to different parts of the layer. Alternatively the several values of capacitance may be averaged.

The liquid crystal material may be nematic or a long pitch cholesteric so the display operates as a twisted nematic display, or the material may be a cholesteric material so the display operates as a phase change display.

The invention will now be described, by way of example only, with reference to the accompanying drawings of which:-

Figure 1 is a front view of a four digit numeric display;

Figure 2 is a cross sectional view of Figure 1;

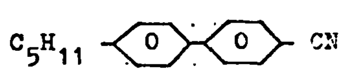
Figure 3 is a schematic view of an x, y matrix display having a temperature compensated voltage supply;

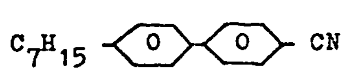
Figure 4, 5, 6, 7 and 8 are graphs showing characteristics of the display of Figures 1 and 2.

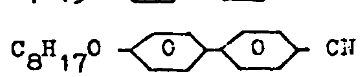
The display of Figures 1, 2 comprise a liquid crystal cell 1 having two glass slides 2, 3 spaced 12 μm apart by a spacer 4. The inner faces of the slides 2, 3 carry electrode patterns 5, 6 collectively forming four seven bar plus decimal point characters 8, 9, 10, 11. Each numeric number 8 to 11 is arranged to be addressed in a multiplexed manner. The eight parts of each character and point are referenced a to h. On the front slide 2 elements are interconnected in three groups e.g. a and b; c, g and f; d, e and h; whilst on the rear slide 3 elements are interconnected in three groups a, f, and h; b, g and e; c and d. Thus each character 8 to 11 can be considered as a 3 x 3 matrix and the four characters collectively as a three line by twelve column matrix.

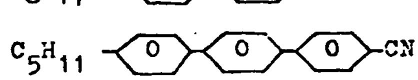
The two small sensing electrodes 12, 13 are arranged, one on each slides 2, 3 facing one another to form part of a temperature sensing circuit.

Between the slides 2, 3 is a layer of liquid crystal material 14 having a positive dielectric anisotropy and may be nematic or a nematic doped with an optically active material such as d-menthol or about 0.2% of cholesterol nonanoate. One suitable material is E7 having the following composition:


51% by weight


25% by weight


16% by weight


8% by weight.

Prior to assembly the inner face of both slides 2, 7 are treated to provide a surface alignment e.g. unidirectional rubbing or oblique evaporation of silicon monoxide as described in U.K. Patent Specifications Nos. 1,472,247 and 1,478,592. The slides are assembled with the alignment (e.g. rubbing directions) orthogonal so that the liquid crystal molecules in the layer 14 progressively twist through 90^{o} across the layer thickness. The layer is thus optically active and rotates the plane of plane polarised light through 90^{o}.

A polariser 15 and an analyser 16 are arranged either side of the cell 1 with their polarisation axis parallel to one another and to one alignment direction.

In operation with zero voltage applied across the layer 14 no light is transmitted through the display. When a suitable voltage is applied across the layer 14 its molecules rotate to lie parallel with the applied electric field. In this condition the liquid crystal layer no longer rotates the plane of polarised light and so passes through the display.

The manner in which light passing through the display varies with applied voltage is shown in Figure 4. If crossed polarisers were used the transmission curve would be inverted with maximum transmission at zero voltage. From Figure 4 is can be seen that a critical voltage V_c typically about 1 volts is required before any change in transmission occurs, and at a saturation voltage V_{sat} typically 2 volts about 90% transmission occurs. The values of V_c and V_{sat} vary with temperature as shown in Figure 5. Since multiplexed displays operate with voltages close to V_c it is necessary to limit the temperature range of operation, for a given liquid crystal, or compensate for this variation of V_c and V_{sat}.

The volume of liquid crystal between electrodes forms a high impedance capacitor. Figure 3 shows an equivalent circuit with a 10 KHz sinewave voltage source V_o connected across a capacitor C_{LC}, and an impedance Z_f. The voltage V_{LC} across C_{LC} is fed into a buffer amplifier 20 and thence into control logic 21 for an x, y matrix display 22. A pedestal voltage V_p is also fed into

the amplifier 20 from a voltage source. The capacitor C_{LC} is formed by the liquid crystal 14 between the sensing electrodes 12, 13, and is typically about 600pF for a one square cam area when the material is OFF and about 1800pF when the material is ON.

Figure 6 shows how V_{LC} changes with temperature for a number of values of Z_f. Three values of Z_f were chosen 270pF, 1,000pF, and 1800pF and for each value of Z_f V_o(at 10 kHz sine wave) was adjusted to give a V_{LC} of 1.0, 1.5 and, 2.1 volts r.m.s. at about 20°C. When V_{LC} was about 1.5 volts at 20°C the values of V_o for Z_f = 270pF, 1,000pF, and 1,800pF were 7.5, 3.7, and 2.8 volts r.m.s. respectively. For values of V_{LF} about 1.5 volts, at about 20°C, and Z_f = 270pF or 1,000pF the change of V_{LC} is approximately linear over the range 0°-50° and is used to control the gain and hence the voltage output from the amplifier 20 to the control logic 21 and display 22. All voltages are r.m.s. values.

Figure 7 shows how the transmission of the liquid crystal varies as a function of temperature for the steep part of the transmission curves, Figure 4, both for the case of a fixed supply voltage (2 volts r.m.s.) with no temperature compensation, and for a temperature compensated voltage. The uncompensated curve varies from 95% transmission at 0°C to 6% at 50°C. By comparison, with compensation, the transmission varies by only ± 5% over the same temperature range.

Figure 8 shows how the capacitance of a liquid crystal layer changes with applied voltage for a number of temperatures.

The matrix display 22 is addressed in a conventional third select manner. For example a voltage of 2V is scanned line by line down the line X electrodes whilst + or - V is connected as appropriate to the column y electrodes as each line receives 2V to give + 3V or V at each x y intersection. The r.m.s. value ON elements is arranged to be at or above saturated whilst V is just below threshold voltage.

0002920

In a modification the position of C_{LC} and Z_f are reversed.

In a further modification the voltage level between C_{LC} and Z_f is held constant and the value of V_o allowed to float. This floating value of V_o is then fed into the logic 21 at a level suitable for applying to the display.

(not shown) when the teeth 7a of the larger diameter gear wheel 7 reach the upper dead point O_1 thereof.

Referring to Figure 3, the chain guide is shifted to the low speed position, so that the chain in mesh with the larger diameter gear wheel 7 remains thereon at a forward portion in the forward direction Y of rotation of the multi-stage gear assembly 6 and shifts radially outwardly of the smaller diameter gear wheel 8 at a portion adjacent the derailleur to adopt an oblique pathway as shown in the drawing.

At this stage, when the crank arms 3 and 4 turn to position the point of engagement of the chain 10 with the larger gear wheel 7 at the teeth 7a of the upper dead point O_1 on the larger diameter gear wheel 7, the chain 10 can quickly come off the teeth 7a.

When switching the chain at the upper dead point, the torque produced by pedalling reaches a minimum value whereby even when the bicycle is running on an up-hill road the conventional return spring can reliably change the bicycle speed.

As may be clearly understood from the above description, the multi-stage gear crank of the invention enables the chain to be switched from the larger gear wheel to the smaller gear wheel when the torque produced by pedalling is at a minimum, whereby the bicycle speed can reliably be changed during running on an up-hill road without the need for increasing the return spring force and modifying pedalling strength. Hence, less force is enough to change the bicycle speed and also the larger diameter gear wheel and drive chain are not subjected to excessive forces when changing speed thereby permitting longer life of the parts.

Furthermore, there is no need for the pedalling force to be reduced when changing speed while the bicycle is running on an up-hill road. Thus the bicycle is not restricted in the obtaining of maximum efficiency therefrom.

CLAIMS:

1. A multi-stage gear crank for a cycle, comprising a crank shaft (1), a pair of crank arms (3, 4) mounted at opposite axial ends of said crank shaft (1), and at least one larger diameter gear wheel (7) and at least one smaller diameter gear wheel (8), said gear wheels (7, 8) being mounted for rotation with one of said crank arms (4) and having a plurality of teeth for meshing with a drive chain (10), characterised in that said larger diameter gear wheel (7) is provided in the vicinity of upper and lower dead points (01, 02) thereof opposite said crank arms (3, 4) with at least one tooth (7a) which has chain detaching means for facilitating displacement of the chain (10) from said larger diameter gear wheel (7).

2. A multi-stage gear crank as claimed in Claim 1, wherein each said at least one tooth (7a) having chain detaching means is in the form of a tooth (7a) which is smaller in height than the other teeth of said gear wheel (7).

3. A multi-stage gear crank as claimed in Claim 1, wherein each said at least one tooth (7a) having chain detaching means is in the form of a tooth (7a) which tooth is displacedfrom a centre line (X) in the plane of said larger diameter gear wheel (7) to one side of said larger diameter gear wheel (7) remote from said smaller diameter gear wheel (8).

4. A multi-stage gear crank as claimed in Claim 1, wherein each said at least one tooth (7a) having chain detaching means is in the form of a tooth (7a) disposed obliquely with respect to a centre line (X) in the plane of said larger diameter gear wheel (7), each said tooth diverging away from said smaller diameter gear wheel (8) in the forward direction of rotation (Y) of said larger diameter gear wheel (7).

5. A multi-stage gear crank as claimed in Claim 1, wherein each said at least one tooth (7a) having chain detaching means is in the form of a tooth (7a) which is chamfered (a) on its outer side remote from said smaller diameter gear wheel (8) at its rearward end with respect to the forward direction of rotation (Y) of said larger diameter gear wheel (7).

6. A multi-stage gear crank as claimed in Claim 1, wherein each said at least one tooth (7a) having chain detaching means is in the form of a tooth (7a) which is chamfered (a) at one side parallel to a centre line (X) in the plane of said larger diameter gear wheel (7), whereby it has a smaller thickness than the other teeth of said larger diameter gear wheel (7)

7. A multi-stage gear crank as claimed in Claim 6, wherein said teeth (7a) are chamfered (a) on the side of the larger diameter gear wheel (7) adjacent said smaller diameter gear wheel (8).

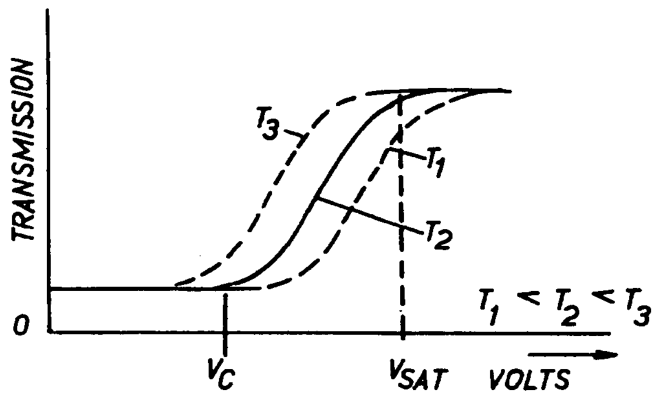


FIG. 4

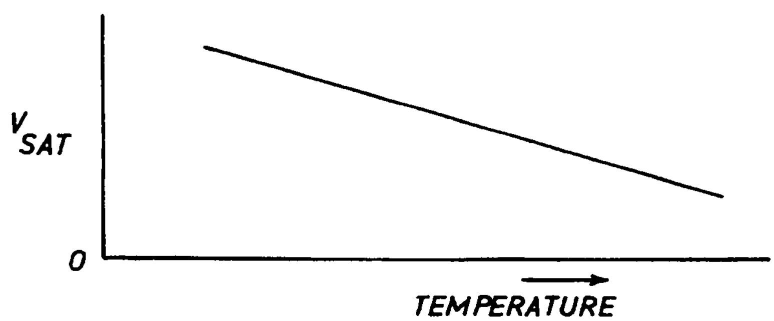


FIG. 5

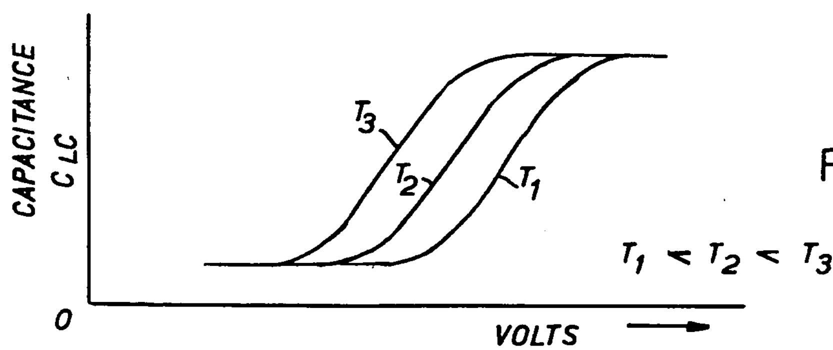
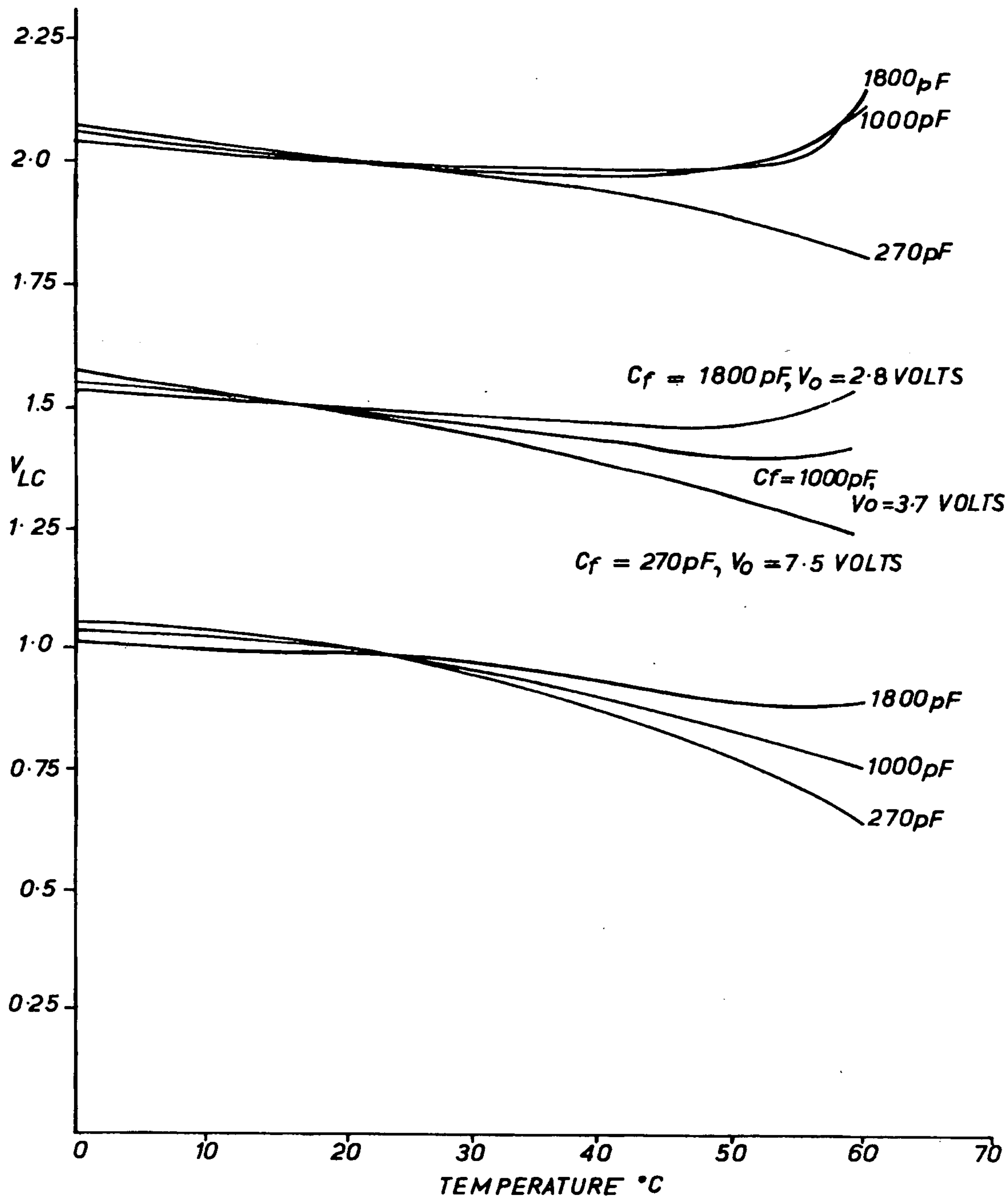
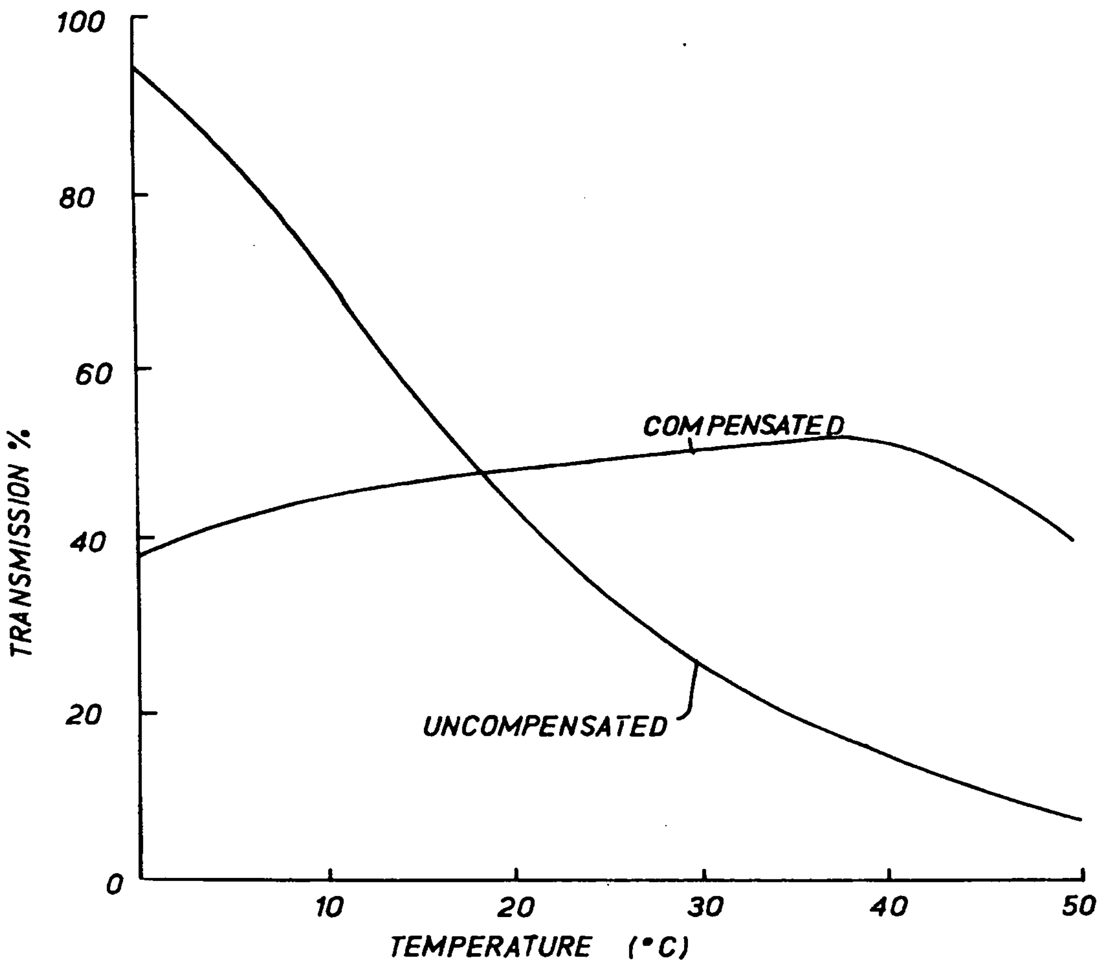


FIG. 8



2·25
2·0
1·75
1.5
1· 25
1·0
0·75
0·5
0·25
V_{LC}
1800pF
1000pF
270pF
C_f = 1800 pF, V_o = 2·8 VOLTS
Cf = 1000pF, Vo = 3·7 VOLTS
C_f = 270pF, V_o = 7·5 VOLTS
1800pF
1000pF
270pF
0
10
20
30
40
50
60
70
TEMPERATURE °C

FIG. 6



100
80
60
40
20
0
TRANSMISSION %
COMPENSATED
UNCOMPENSATED
10
20
30
40
50
TEMPERATURE (°C)

FIG. 7

European Patent Office

EUROPEAN SEARCH REPORT

0002920

Application number

EP 78 30 0846

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim
X	US - A - 4 045 791 (MASAKAZU FUKAI) * Column 6, lines 57-64; column 7, line 57 - column 8, line 8; column 13, lines 40-68; column 14, lines 1-19; claims 1,2,8; figures 7,21 * ----	1-3,5

CLASSIFICATION OF THE APPLICATION (Int. Cl.²)

G 02 F 1/13

TECHNICAL FIELDS SEARCHED (Int.Cl.²)

G 02 F 1/13

CATEGORY OF CITED DOCUMENTS

X: particularly relevant
A: technological background
O: non-written disclosure
P: intermediate document
T: theory or principle underlying the invention
E: conflicting application
D: document cited in the application
L: citation for other reasons

&: member of the same patent family, corresponding document

X The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	05-04-1979	ARMITANO GRIVEL

EPO Form 1503.1 06.78

Europäisches Patentamt
European Patent Office
Office européen des brevets

(19) (11) Publication number: 0 002 920 B1

(12) # EUROPEAN PATENT SPECIFICATION

(45) Date of publication of patent specification: 13.01.82
(51) Int. Cl.³: G 02 F 1/133
(21) Application number: 78300846.9
(22) Date of filing: 18.12.78

(54) Liquid crystal displays.

(30) Priority: 20.12.77 GB 5304177
12.04.78 GB 1442478

(43) Date of publication of application:
11.07.79 Bulletin 79/14

(45) Publication of the grant of the European patent:
13.01.82 Bulletin 82/2

(84) Designated Contracting States:
CH DE FR NL

(56) References cited:
US - A - 4 045 791

(73) Proprietor: The Secretary of State for Defence in Her Britannic Majesty's Government of the United Kingdom of Great Britain and Northern Ireland Whitehall London S.W.1. (GB)

(72) Inventor: Hilsum, Cyril
24, Geraldine Road
Malvern Hereford and Worcester (GB)
Inventor: Raynes, Edward Peter
23, Leadon Road Hall Green
Malvern Hereford and Worcester (GB)

(74) Representative: Edwards, John Brian et al,
Procurement Executive Ministry of Defence
Patents 1 A (4), Room 1932, 19th Floor Empress
State Building Lillie Road
London SW6 1TR (GB)

EP 0 002 920 B1

Courier Press, Leamington Spa, England.

Liquid crystal displays

This invention relates to liquid crystal displays and concerns the compensation of electrical characteristics with temperature.

Liquid crystal displays are commonly formed by enclosing a thin, typically 12 μm thick, layer of liquid crystal material between two glass slides. Electrodes on the slides inner face enable a voltage to be applied across the liquid crystal layer.

Application of a voltage above a threshold value causes a change in the molecular alignment of the liquid crystal molecules i.e. to an 'ON' state. On removing the voltage the molecules relax back to their 'OFF' state.

This voltage controlled molecular alignment is used in various types of liquid crystal displays, e.g. twisted nematic, and phase change effect displays. To display numerics, symbols, or waveform parts of the layer are caused to be ON whilst other parts are OFF. This is achieved by shaping the electrodes into e.g. 7 bar displays or e.g. arranging the electrodes as row or column strip electrodes on the two slides to form an x, y matrix, or radial and curved, strip electrodes to form a polar co-ordinate ($r — \theta$) display.

An x, y or r, θ matrix array or seven bar display arranged in a matrix format may be addressed in a multiplexed manner, e.g. apply voltages to the whole display a line at a time. If the scan time is much shorter than the natural response time of the liquid crystal the display appears constant (no flicker).

The threshold voltage of a liquid crystal material, for a given layer thickness, varies with temperature and limits the complexity of multiplexed displays.

One way of overcoming this problem of threshold voltage variation is to maintain the liquid crystal layer at a uniform temperature using sensors and heaters.

Another way is to measure the ambient or the liquid crystal temperature and vary the addressing voltages accordingly as described in Patent Specificaton Numbers U.S.A. 4,045,791 and U.K. 1,426,896. The temperature is measured by a thermistor or bimetallic strip, or by measuring changes in liquid crystal resistance with temperature. Unfortunately liquid crystal material has an extremely high resistance in its pure state which makes such measurement difficult. Any measurable resistance is due to impurities and these may change with time. For example impurities from the cell construction, e.g. glass walls and adhesive, may gradually contaminate the liquid crystal material.

The present invention overcomes these disadvantages by using the capacitance of a liquid crystal cell as it changes with temperature to control addressing voltages level applied to the display.

According to the invention a liquid crystal display comprises two spaced slides at least one of which is transparent having on their facing surfaces electrode structures, a layer of liquid crystal material contained between the slides, control logic for applying addressing voltages to the electrodes, and a temperature detector circuit for varying the addressing voltages in accordance with the liquid crystal temperature, characterised by a liquid crystal capacitor formed by sensing electrodes and a part of the liquid crystal layer, a reference capacitor, and a voltage source for applying a voltage across the liquid crystal capacitor and reference capacitor in series, with the voltage across the liquid crystal capacitor lying between the threshold value and the saturation value, the addressing voltage level applied by the control logic being controlled by the voltage developed across the liquid crystal capacitor.

The means for using the voltage developed across the portion of the layer may include an amplifier which adds or subtracts a control voltage from a supply voltage applicable to the display portion of the cell.

In large displays, e.g. matrix addressed displays, the capacitance may be monitored at different parts of the layer independently and used to compensate voltage applied to different parts of the layer. Alternatively the several values of capacitance may be averaged.

The liquid crystal material may be nematic or a long pitch cholesteric so the display operates as a twisted nematic display, or the material may be a cholesteric material so the display operates as a phase change display.

The invention will now be described, by way of example only, with reference to the accompanying drawings of which:—

Figure 1 is a front view of a four digit numeric display;

Figure 2 is a cross sectional view of Figure 1;

Figure 3 is a schematic view of an x, y matrix display having a temperature compensated voltage supply;

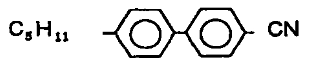
Figure 4, 5, 6, 7 and 8 are graphs showing characteristics of the display of Figures 1 and 2.

The display of Figures 1, 2 comprise a liquid crystal cell 1 having two glass slides 2, 3 spaced 12 μm apart by a spacer 4. The inner faces of the slides 2, 3 carry electrode patterns 5, 6 collectively forming four seven bar plus decimal point characters 8, 9, 10, 11. Each numeric number 8 to 11 is arranged to be addressed in a multiplexed manner. The eight parts of each character and point are referenced a to h. On the front slide 2 elements are interconnected in three groups e.g. a and b; c, g and f; d, e and h; whilst on the rear slide 3 elements are interconnected in three groups a, f, and h; b, g and e; c and d. Thus each character 8 to 11 can be considered as a 3 x 3 matrix and the

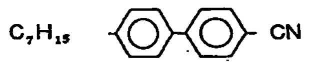
four characters collectively as a three line by twelve column matrix.

The two small sensing electrodes 12, 13 are arranged, one on each slides 2, 3 facing one another to form part of a temperature sensing circuit.

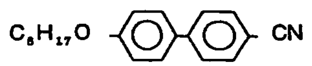
Between the slides 2, 3 is a layer of liquid crystal material 14 having a positive dielectric anisotropy and may be nematic or a nematic doped with an optically active material such as d-menthol or about 0.2% of cholesterol nonanoate. One suitable material is E7 having the following composition:



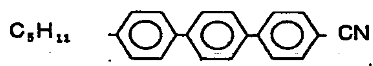
51% by weight



25% by weight



16% by weight



8% by weight

Prior to assembly the inner faces of both slides 2, 7 are treated to provide a surface alignment e.g. unidirectional rubbing or oblique evaporation of silicon monoxide as described in U.K. Patent Specifications Nos. 1,472,247 and 1,478,592. The slides are assembled with the alignment (e.g. rubbing directions) orthogonal so that the liquid crystal molecules in the layer 14 progressively twist through 90° across the layer thickness. The layer is thus optically active and rotates the plane of plane polarised light through 90°.

A polariser 15 and an analyser 16 are arranged either side of the cell 1 with their polarisation axis parallel to one another and to one alignment direction.

In operation with zero voltage applied across the layer 14 no light is transmitted through the display. When a suitable voltage is applied across the layer 14 its molecules rotate to lie parallel with the applied electric field. In this condition the liquid crystal layer no longer rotates the plane of polarised light and so light passes through the display.

The manner in which light passing through the display varies with applied voltage is shown in Figure 4 for three different temperatures T_1, T_2, T_3. If crossed polarisers were used the transmission curve would be inverted with maximum transmission at zero voltage. From Figure 4 it can be seen that a threshold voltage V_c typically about 1 volt is required before any change in transmission occurs, and at a saturation voltage V_{sat} typically 2 volts about 90% transmission occurs. The value of V_{sat} varies with temperature as shown in Figure 5. Since multiplexed displays operate with voltages close to V_c it is necessary to limit the temperature range of operation, for a given liquid crystal, or compensate for this variation of V_c and V_{sat}.

The volume of liquid crystal between electrodes forms a high impedance capacitor. Figure 3 shows an equivalent circuit with a 10 KHz sinewave source V_o connected across a capacitor C_{LC}, and a capacitive impedance Z_f formed by capacitor C_f. The voltage V_{LC} across C_{LC} is fed into a buffer amplifier 20 and thence into control logic 21 for an x, y matrix display 22. A pedestal voltage V_p is also fed into the amplifier 20 from a voltage source. The capacitor C_{LC} is formed by the liquid crystal 14 between the sensing electrodes 12, 13, and is typically about 600pF for a one square cam area when the material is OFF and about 1800pF when the material is ON.

Figure 6 shows how V_{LC} changes with temperature for a number of values of C_f. Three values of C_f were chosen 270pF, 1,000pF, and 1800pF and for each value of C_f V_o (at 10 kHz sine wave) was adjusted to give a V_{LC} of 1.0, 1.5 and, 2.1 volts r.m.s. at about 20°C. When V_{LC} was about 1.5 volts at 20°C the values of V_o for C_f = 270pF, 1,000pF, and 1,800pF were 7.5, 3.7, and 2.8 volts r.m.s. respectively. For values of V_{LC} about 1.5 volts, at about 20°C, and C_f = 270pF or 1,000pF the change of V_{LC} is approximately linear over the range 0°—50°C and is used to control the gain and hence the voltage output from the amplifier 20 to the control logic 21 and display 22. All voltages are r.m.s. values.

Figure 7 shows how the transmission of the liquid crystal varies as a fucntion of temperature for the steep part of the transmission curves, Figure 4, both for the case of a fixed supply voltage (2 volts r.m.s.) with no temperature compensation, and for a temperature compensated voltage. The uncompensated curve varies from 95% transmission at 0°C to 6% at 50°C. By comparison, with compensation, the transmission varies by only ±5% over the same temperature range.

Figure 8 shows how the capacitance of a liquid crystal layer changes with applied voltage for a number of temperatures, T_1, T_2 and T_3.

The matrix display 22 is addressed in a conventional third select manner. For example a

voltage of 2V is scanned line by line down the line X electrodes whilst + or −1V is connected as appropriate to the column y electrodes as each line receives 2V to give +3V or 1V at each x y intersection. The r.m.s. value ON elements is arranged to be at or above saturated whilst V is just below threshold voltage V_c.

In a modification the positions of C_{LC} and Z_f are reversed.

In a further modification the voltage level between C_{LC} and Z_f is held constant and the value of V_o allowed to float. This floating value of V_o is then fed into the logic 21 at a level suitable for applying to the display.

Claims

1. A liquid crystal display (1, 22) comprising two spaced slides (2, 3) at least one of which is transparent having on their facing surfaces electrode structures (5, 6), a layer (14) of liquid crystal material contained between the slides (2, 3), control logic (21) for applying addressing voltages to the electrodes (5, 6), and a temperature detector circuit for varying the addressing voltages in accordance with the liquid crystal (14) temperature, characterised by a liquid crystal capacitor (C_{LC}) formed by sensing electrodes (12, 13) and a part of the liquid crystal layer (14), a reference capacitor (C_f), and a voltage source (V_o) for applying a voltage across the liquid crystal capacitor (C_{LC}) and reference capacitor (C_f) in series, with the voltage (V_{LC}) across the liquid crystal capacitor (C_{LC}) lying between the threshold value (V_c) and the saturation value (V_{sat}), the addressing voltage level applied by the control logic (21) being controlled by the voltage (V_{LC}) developed across the liquid crystal capacitor (C_{LC}).

2. A display according to claim 1 wherein the value of V_o can be held at an adjustable steady value.

3. A display according to claim 1 wherein the voltage V_{LC} across the liquid crystal capacitor (C_{LC}) is held at an adjustable steady value.

4. A display according to claim 2 characterised by a plurality of pairs of sensing electrodes (12, 13).

5. A display according to claim 1 characterised by an amplifier (20) for providing a compensated voltage supply to a display (1, 21, 22).

6. A display according to claim 1 characterised by a display liquid crystal layer (14) having a twisted structure that rotated the plane of plane polarised light.

7. A display according to claim 6 characterised by a layer (14) of nematic liquid crystal material and surface alignment on the slide (2, 3) surface.

8. A display according to claim 7 characterised by a small amount of a cholesteric material in the nematic liquid crystal layer (14).

9. A display according to claim 1 characterised by a display (1, 22) arranged to be addressed in a multiplexed manner.

Revendications

1. Un tableau d'affichage (1, 22) en cristal liquide comportant deux plaques espacées, dont l'une est transparente, portant sur leur surface de portée des structures d'électrodes (5, 6, x, y), une couche de matériau à cristal liquide contenu entre les plaques (2, 3), une logique de contrôle (21) qui applique les tensions d'adresse aux électrodes (5, 6, x, y), et un circuit de détection qui vait varier les tensions d'adresse en fonction de la température du crystal liquide, caractérisé par un condensateur à cristal liquide (C_{LC}) constitué d'électrodes détecteurs (12, 13) et d'une partie de la couche de cristal liquide (14), un condensateur de référence (Z_f), et une source de tension pour l'application d'une tension à travers le condensateur à cristal liquide (C_{LC}) et un autre condensateur de référence, (Zf) en série avec la tension (V_{LC}) passant à travers le condensateur à cristal liquide (G_{LC}) dont la valeur se situe entre la valeur-seuil (V_c) et la valeur de saturation (V_{sat}), le niveau de tension d'adresse appliquée par la logique de commande étant contrôlée par la tension (V_{LC}) développée à travers le condensateur à cristal liquide (C_{LC}).

2. Un tableau d'affichage tel que défini dans la revendication 1 où la valeur de V_o peut être maintenue à une valeur constante réglable.

3. Un tableau d'affichage tel que défini dans la revendication 1 où la tension V_{LC} passant à travers le condensateur à cristal liquide (C_{LC}) est maintenue à une valeur constante réglable.

4. Un tableau d'affichage tel que défini dans la revendication 2 caractérisé par une pluralité d'électrodes détecteurs (12, 13).

5. Un tableau d'affichage tel que défini dans la revendication 1 caractérisé par un amplificateur (20) destiné à fournir une tension compensée à un système d'affichage (1, 21, 22).

6. Un tableau d'affichage tel que défini dans la revendication 1 caractérisé par une couche de cristal liquide pour système d'affichage (19) comportant une structure en torsade qui fait tourner le plan de la lumière polarisée dans un plan.

7. Un tableau d'affichage tel que défini dans la revendication 6 caractérisé par une couche (14) de matériau nomatique en crystal liquide et l'alignement des molécules extérieures du cristal liquide avec la surface des plaques (2, 3) portant les structures.

8. Un tableau d'affichage tel que défini dans la revendication 7 caractérisé par une petite quantité d'un matériau cholestérique dans la couche de cristal liquide nomatique (14).

9. Un tableau d'affichage tel que défini dans la revendication 4 caractérisé par un tableau d'affichage (1, 22) organisé de façon à être adressée en mode multiplexe.

Patentansprüche

1. Eine Flüssigkristall-Anzeige (1, 22) bestehend aus zwei parallel angeordneten Scheiben (2, 3) von denen mindestens eine durchsichtig ist, und die auf ihren gegenüberstehendenden Flächen Elektrodenstrukturen (5, 6, x, y) aufweisen; zwischen den beiden Scheiben (2, 3) ist eine aus Flüssigkristallmaterial bestehende Schicht (14) enthalten; eine Steuerlogik (21) legt Adressierspannungen an den Elektroden (5, 6, x, y) an, und ein Temperaturdetektorkreis variiert die Adressierspannungen je nach der Temperatur des Flüssigkristalls (14); der Detektorkreis ist gekennzeichnet durch einen Flüssigkristallkondensator (C_{LC}), der aus Abtastelektroden (12, 13) und einem Teil der Flüssigkristallschicht (14) gebildet ist, sowie durch einen Normalkondensator (Z_f) und eine Stromquelle (V_o), die eine Spannung am Flüssigkristallkondensator (C_{LC}) und am Normalkondensator (Z_f) anlegt; diese Spannung ist in Reihe geschaltet mit der am Flüssigkristall (C_{LC}) angelegten Spannung (V_{LC}) und hat einen Wert, der zwischen dem Schwellenwert (V_C) und dem Sättrigungswert (V_{sat}) liegt; die Höhe der durch die Steuerlogik (21) angelegten Adressierspannung wird mittels der am Flüssigkristallkondensator (C_{LC}) entwickelten Spannung (V_{LC}) geregelt.

2. Eine Anzeige gemäss Anspruch 1, wobei der Wert von V_o bei einem einstellbaren Dauerwert gehalten werden kann.

3. Eine Anzeige gemäss Anspruch 1, wobei die Spannung V_{LC} am Flüssigkristallkondensator (C_{LC}) bei einem einstellbaren Dauerwert gehalten wird.

4. Eine Anzeige gemäss Anspruch 2, dadurch gekennzeichnet, dass mehrere Abtastelektrodenpaare vorhanden sind.

5. Eine Anzeige gemäss Anspruch 1, dadurch gekennzeichnet, dass ein Verstärker (20) verhanden ist, der die Anzeige (1, 21, 22) mit einer kompensierten Spannung versorgt.

6. Eine Anzeige gemäss Anspruch 1, dadurch gekennzeichnet, dass die Flüssigkristallschicht der Anzeige eine verdrehte Form hat, wodurch die Ebene eines linear polarisierten Lichtes verdreht wird.

7. Eine Anzeige gemäss Anspruch 6, gekennzeichnet durch Verwendung einer nematischen Flüssigkristallschicht (14) sowie durch Ausrichtung derselben zu der jeweiligen Scheibenfläche (2, 3).

8. Eine Anzeige gemäss Anspruch 7, dadurch gekennzeichnet, dass die nematische Flüssigkristallschicht (14) eine kleine Menge eines cholesterischen Materials enthält.

9. Eine Anzeige gemäss Anspruch 1, dadurch gekennzeichnet, dass die Anzeige (1, 22) so ausgelegt ist, dass sie nach dem Multiplexverfahren adressiert werden kann.

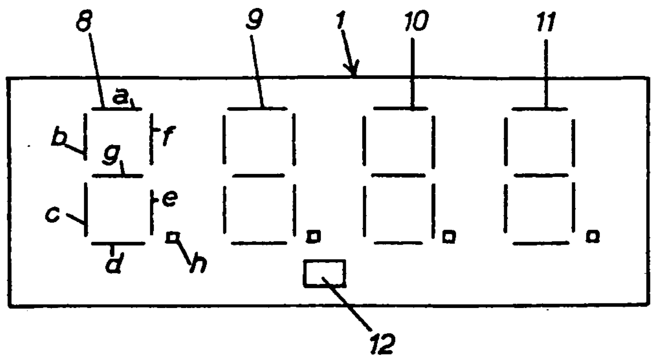


FIG. 1

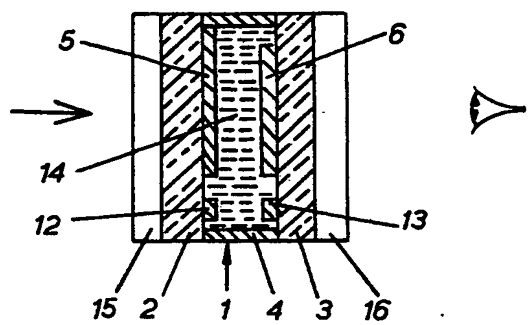


FIG. 2

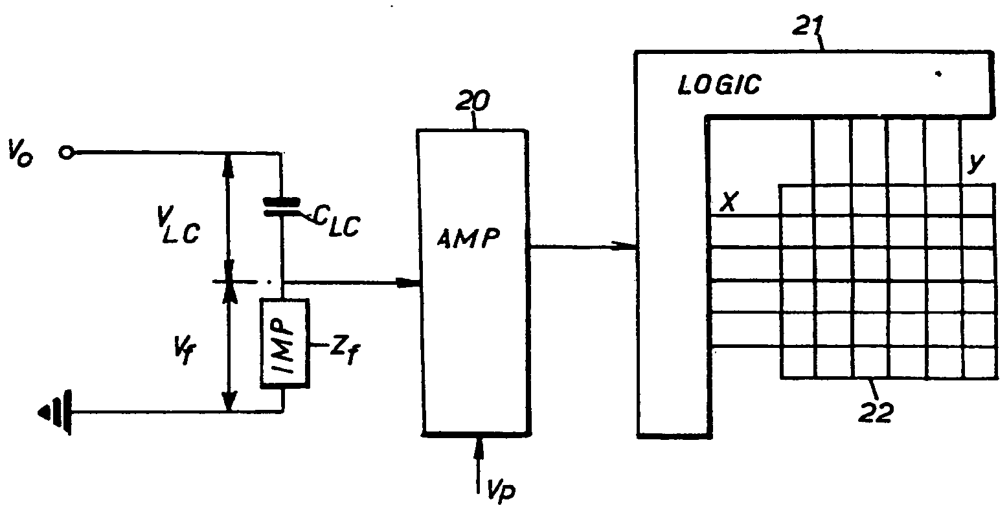


FIG. 3

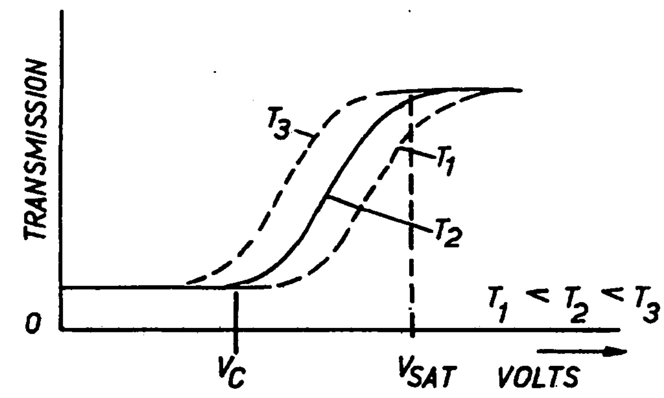


FIG. 4

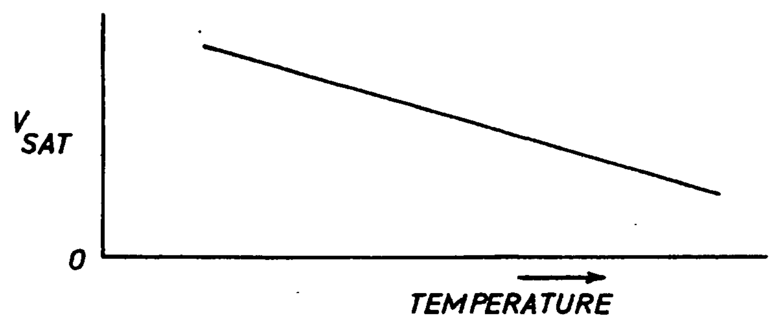


FIG. 5

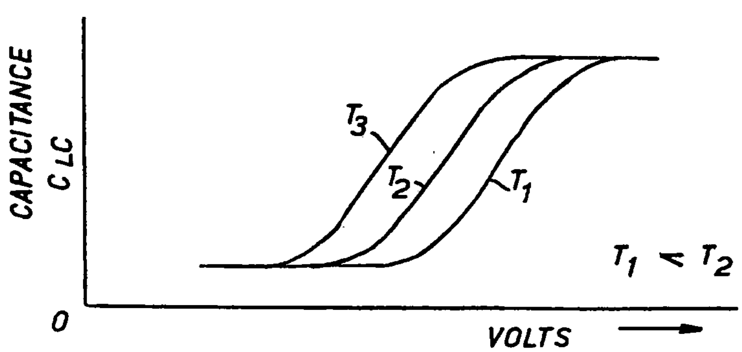


FIG. 8

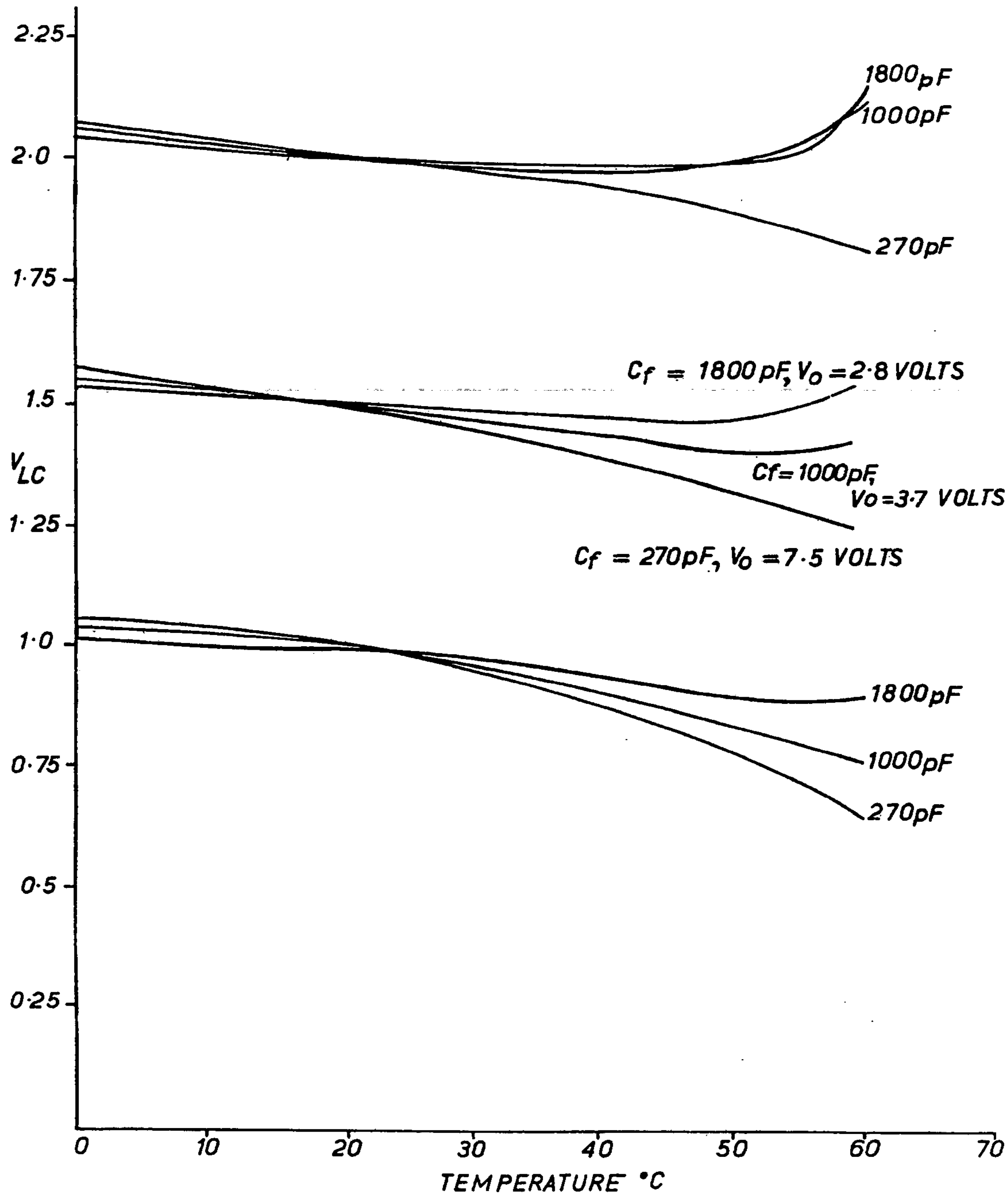

2·25
2·0
1·75
1.5
1· 25
1·0
0·75
0·5
0·25
V LC
1800pF
1000pF
270pF
Cf = 1800 pF, Vo = 2·8 VOLTS
Cf = 1000pF, Vo = 3·7 VOLTS
Cf = 270pF, Vo = 7·5 VOLTS
0
10
20
30
40
50
60
70
TEMPERATURE °C

FIG. 6

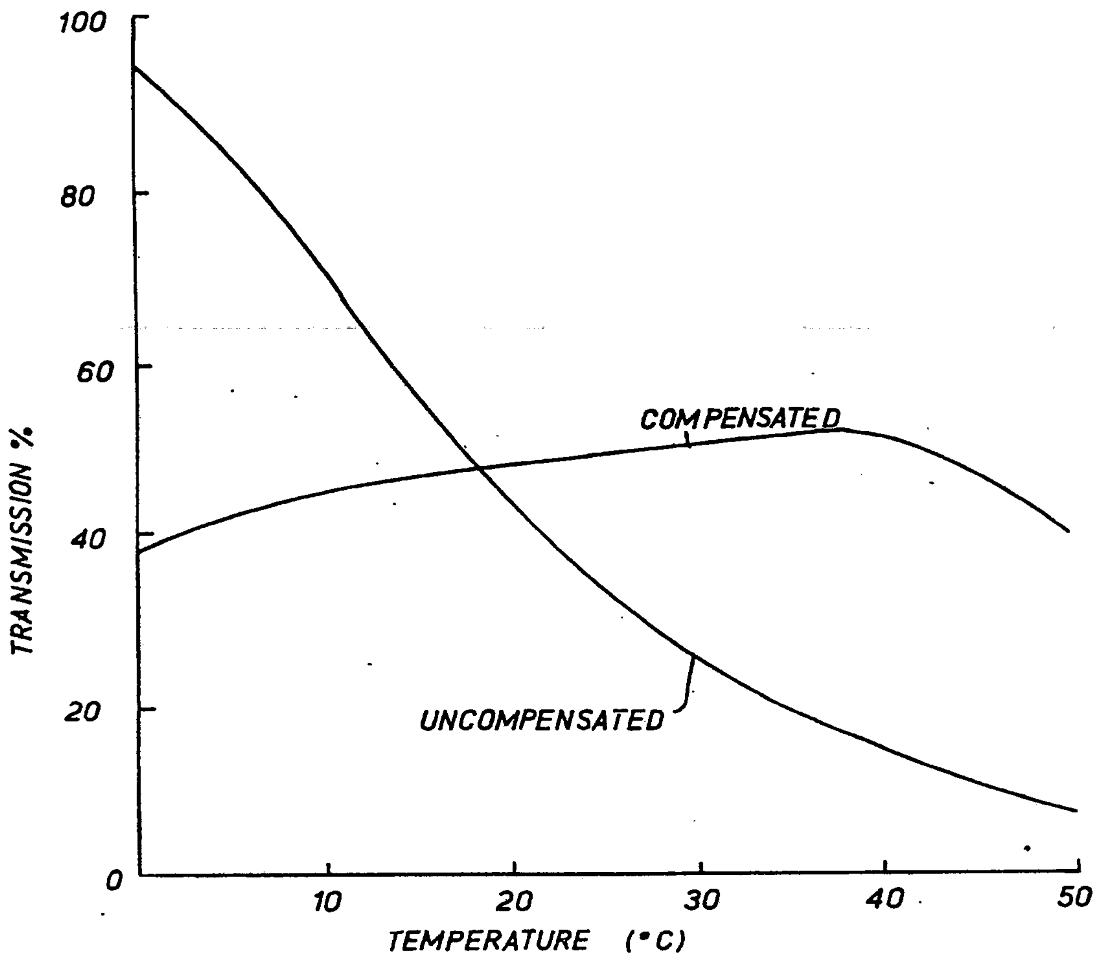

100
80
60
40
20
0
TRANSMISSION %
COMPENSATED
UNCOMPENSATED
10
20
30
40
50
TEMPERATURE (°C)

FIG. 7